

THAT WHICH IS CLAIMED:

1. A graphics processing method, comprising:
defining a plurality of rows of tiles in a graphics display field comprising a plurality of rows of pixels, each tile including pixels from at least two rows of pixels;
setting occlusion flags for respective tiles of a row of tiles for a graphics
5 primitive based on whether respective representative depth values for the tiles of the row of tiles meet an occlusion criterion;
processing pixels in rows of pixels corresponding to the row of tiles for the graphics primitive in a row-by-row manner responsive to the occlusion flags.
- 10 2. A method according to Claim 1, wherein processing pixels comprises:
processing a portion of the pixels in a first tile of the row of tiles responsive to the occlusion flags; and then
possibly processing pixels in a second tile of the row of tiles responsive to the occlusion flags before processing additional pixels in the first tile responsive to the
15 occlusion flags.
3. A method according to Claim 2, wherein processing pixels comprises processing rows of pixels in the row of tiles using a zig-zag traversal algorithm.
- 20 4. A method according to Claim 2:
wherein the occlusion flags are stored in a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles and respective occlusion threshold depth values for the respective tiles of the row of tiles; and wherein setting occlusion flags comprises:
25 determining a maximum depth value for the graphics primitive for a tile;
comparing the maximum depth value to the cached occlusion threshold depth value for the tile in the tile occlusion information cache; and
setting the occlusion flag for the tile responsive to the comparison.
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5. A method according to Claim 4, further comprising:
establishing a depth buffer configured to store respective occlusion threshold
depth values for respective pixels of the graphics display field; and
wherein setting the occlusion flags comprises setting an occlusion flag for a
5 tile to indicate non-occlusion; and
wherein processing pixels comprises:
detecting that the tile has a occlusion flag indicating non-occlusion;
and
responsively processing a pixel for the graphics primitive in the tile
10 without retrieving an occlusion threshold depth value for the pixel from the
depth buffer.
6. A method according to Claim 5, further comprising establishing a
color buffer configured to store respective color values for respective ones of the
15 pixels of the graphics display field, and wherein responsively processing a pixel for
the graphics primitive in the tile without retrieving an occlusion threshold depth value
for the pixel from the depth buffer comprises responsively storing a color value and a
depth value for the graphics primitive for the pixel in the color buffer and the depth
buffer, respectively.
- 20 7. A method according to Claim 6, wherein the occlusion flags are stored
in a tile occlusion information cache that is configured to store respective occlusion
flags for respective tiles of a row of tiles, respective occlusion threshold depth values
for the respective tiles of the row of tiles, and wherein the method further comprises:
25 determining a depth value for the graphics primitive for the pixel;
comparing the determined depth value for the graphics primitive for the pixel
to the occlusion threshold depth value for the tile in the tile occlusion information
cache; and
updating the occlusion threshold depth value for the tile in the tile occlusion
30 information threshold cache to the determined depth value for the graphics primitive
for the pixel responsive to the comparison.

8. A method according to Claim 7:

wherein setting occlusion flags comprises setting an occlusion flag for a tile to indicate non-occlusion, and wherein processing pixels is preceded by:

establishing an aggregate tile occlusion information memory configured to
5 store respective occlusion threshold depth values for all of the rows of tiles; and
loading the tile occlusion information cache with occlusion threshold depth
values from the aggregate time occlusion information memory; and

wherein updating the occlusion threshold depth value for the tile in the tile
occlusion information threshold cache is followed by updating threshold occlusion
10 depth values in the aggregate tile occlusion information memory from the tile
occlusion information cache.

9. A method according to Claim 1, further comprising:

establishing a depth buffer configured to store respective occlusion threshold
15 depth values for respective pixels of the graphics display field; and

wherein setting occlusion flags comprises setting the occlusion flag for a tile
to indicate possible occlusion; and

wherein processing pixels comprises:

detecting that the tile has an occlusion flag indicating possible
20 occlusion; and

comparing a depth value for the graphics primitive for a pixel in the
tile to an occlusion threshold depth value for the pixel in the depth buffer
responsive to detecting that the tile has an occlusion flag indicating possible
occlusion;

25 processing the pixel responsive to the comparison; and

updating the occlusion threshold depth value for the tile in the tile
occlusion information cache responsive to the written z-value of the pixel.

10. A method according to Claim 9, further comprising establishing a
30 color buffer configured to store respective color values for respective ones of the
pixels of the graphics display field, and wherein processing the pixel comprises
storing a color value and a depth value in the color buffer and the depth buffer,
respectively, if the comparison of the depth value for the graphics primitive for the
pixel in the tile to the occlusion threshold depth value for the pixel in the depth buffer

indicates non-occlusion and updating the occlusion threshold depth value for the tile in the tile occlusion information cache responsive to the written z-value of the pixel.

11. A method according to Claim 1, wherein the occlusion flags are stored
5 in a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles, respective occlusion threshold depth values for the respective tiles of the row of tiles, and respective status flags for respective tiles of the row of tiles, and wherein the method further comprises:

processing a first row of pixels responsive to the tile occlusion information
10 cache, wherein processing a first row of pixels comprises setting occlusion and status flags for at least one tile in the first row of tiles to indicate that occlusion status of the at least one tile has been determined;

determining whether a second row of pixels is in the first row of tiles; and

processing a second row of pixels using information in the tile occlusion cache
15 gained from the first row of pixels if the second row of pixels is in the first row of tiles.

12. A method according to Claim 11, wherein processing a first row of pixels is preceded by:

20 establishing an aggregate tile occlusion information memory configured to store respective occlusion threshold depth values for all tiles in all rows of tiles;

setting the occlusion and status flags in the tile occlusion information cache to predetermined values; and

storing occlusion threshold depth values for the first row of tiles from the
25 aggregate tile occlusion information memory in the tile occlusion information cache.

13. A method according to Claim 1, wherein the occlusion flags are stored
in a tile occlusion information cache that is configured to store respective occlusion
flags for respective tiles of a row of tiles, respective occlusion threshold depth values
30 for the respective tiles of the row of tiles, and respective status flags for respective tiles of the row of tiles, and wherein the method further comprises:

establishing an aggregate tile occlusion information memory configured to store respective occlusion threshold depth values for all tiles of the rows of tiles;

processing a first row of pixels responsive to the tile occlusion information cache, wherein processing a first row of pixels comprises setting occlusion flags and status flags for a first row of tiles having pixels in the first row of pixels to indicate that at least one occlusion status of at least one tile in the first row has been

5 determined;

determining whether a second row of pixels is in the first row of tiles; and

responsive to determining that the second row of pixels is in a second row of tiles, writing back the occlusion threshold depth values from the tile occlusion information cache to the aggregate tile occlusion information in the tile occlusion
10 information cache, loading occlusion threshold depth values into the tile occlusion information cache with corresponding occlusion threshold depth values for the second row of tiles from the aggregate tile occlusion information memory, and processing the second row of pixels using the updated tile occlusion cache.

15 14. A method according to Claim 13, wherein determining whether a second row of pixels is in the first row of tiles is followed by updating occlusion threshold depth values for the first row of tiles in the aggregate tile occlusion information memory with occlusion threshold depth values from the tile occlusion cache responsive to determining that the second row of pixels is in a second row of
20 tiles.

15. An apparatus, comprising:

a display; and

a graphics processor coupled to the display and operative to define a plurality
25 of rows of tiles in a graphics display field of the display, each tile including pixels from at least two rows of pixels, to set occlusion flags for respective tiles of a row of tiles for a graphics primitive based on whether respective representative depth values for the tiles of the row of tiles meet an occlusion criterion, and to process pixels in rows of pixels corresponding to the row of tiles for the graphics primitive in a row-by-
30 row manner responsive to the occlusion flags.

16. An apparatus according to Claim 15, wherein the graphics processor is operative to process a portion of the pixels in a first tile of the row of tiles responsive to the occlusion flags and to then process pixels in a second tile of the row of tiles

responsive to the occlusion flags before processing additional pixels in the first tile responsive to the occlusion flags.

17. An apparatus according to Claim 15, wherein the graphics processor is
5 operative to process rows of pixels in the row of tiles using a zig-zag traversal algorithm.

18. An apparatus according to Claim 15, wherein the representative depth
values comprise maximum depths of the graphics primitive in the tiles, and wherein
10 the occlusion criterion is whether a maximum depth for the graphics primitive in the tile is less than a previously established minimum non-occlusion depth value for the tile.

19. An apparatus according to Claim 15, wherein the display and the
15 graphics processor are housed in a portable electronic device.

20. An apparatus, comprising:
a display; and
a graphics processor coupled to the display and operative to define a plurality
20 of rows of tiles in the graphics display field, each of the tiles comprising a plurality of pixels, to set an occlusion flag for a tile to indicate non-occlusion for a graphics primitive in the tile, to detect that the tile has a occlusion flag indicating non-occlusion, and to responsively process a pixel for a graphics primitive in the tile.

21. An apparatus according to Claim 20, wherein the graphics processor is
25 operative to maintain a depth buffer configured to store respective occlusion threshold depth values for respective pixels of a graphics display field of the display and to process the pixel without retrieving an occlusion threshold depth value from the depth buffer.

22. An apparatus according to Claim 20, wherein the graphics processor is
30 operative to maintain a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles and respective occlusion threshold depth values for the respective tiles of the row of tiles, to

determine a maximum depth value for the graphics primitive for a tile, to compare the maximum depth value to the cached occlusion threshold depth value for the tile in the tile occlusion information cache, and to set the occlusion flag for the tile responsive to the comparison.

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23. A computer program product comprising program code embodied in a computer-readable medium, the program code comprising:

program code configured to define a plurality of rows of tiles in a graphics display field of the display, each tile including pixels from at least two rows of pixels, to set occlusion flags for respective tiles of a row of tiles for a graphics primitive based on whether respective representative depth values for the tiles of the row of tiles meet an occlusion criterion, and to process pixels in rows of pixels corresponding to the row of tiles for the graphics primitive in a row-by-row manner responsive to the occlusion flags.

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24. A computer program product according to Claim 23, wherein the program code is further configured to process a portion of the pixels in a first tile of the row of tiles responsive to the occlusion flags and to then process pixels in a second tile of the row of tiles responsive to the occlusion flags before processing additional pixels in the first tile responsive to the occlusion flags

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25. A computer program product according to Claim 24, wherein the program code is further configured to process rows of pixels in the row of tiles using a zig-zag traversal algorithm.

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26. A computer program product comprising program code embodied in a computer-readable medium, the program code comprising:

program code configured to define a plurality of rows of tiles in the graphics display field, each of the tiles comprising a plurality of pixels, to set an occlusion flag for a tile to indicate non-occlusion for a graphics primitive in the tile, to detect that the tile has a occlusion flag indicating non-occlusion, and to responsively process a pixel for a graphics primitive in the tile.

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27. A computer program product according to Claim 26, wherein the program code is further configured to maintain a depth buffer configured to store respective occlusion threshold depth values for respective pixels of a graphics display field of the display and to process the pixel without retrieving an occlusion threshold
5 depth value from the depth buffer.

28. A computer program product according to Claim 1, wherein the program code is configured to maintain a tile occlusion information cache that is configured to store respective occlusion flags for respective tiles of a row of tiles and
10 respective occlusion threshold depth values for the respective tiles of the row of tiles, to determine a maximum depth value for the graphics primitive for a tile, to compare the maximum depth value to the cached occlusion threshold depth value for the tile in the tile occlusion information cache, and to set the occlusion flag for the tile
responsive to the comparison.

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